Authorship Guidance in a Federal Research Laboratory: A Case Study

Joseph E Flotemersch and Justicia Rhodus

Abstract

As science has become more specialized and collaborative, a need has emerged for research organizations to develop authorship guidance that can be shared and discussed with potential collaborators. We present the guidance developed for a United States (U.S.) federal research laboratory that collaborates with both governmental and nongovernmental colleagues globally. Topics included in the guidance were identified during a review of existing authorship guidelines and discussions with laboratory scientists and managers. Criteria are presented that clearly define what constitutes authorship, and guidance is provided for addressing author order, equal contributorship, unique coauthorship issues, author responsibilities, authorship abuse, contributorship statements, acknowledgments, and dispute resolution. While not exhaustive, this list of topics provides a strong starting point for other scientific research organizations needing to prepare authorship guidance of their own. The views expressed in this article are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Introduction

The executive branch of the United States (U.S.) Federal Government is responsible for enforcing the laws of the land. To effectively accomplish this mission, the government relies on a suite of federal research laboratories that reside in various executive departments and independent agencies. Critical to the success of these laboratory research programs is communication and the utility of their research to influence and impact decisions. Paramount to the communication of this research is the development and distribution of both oral and written scientific and technical products. Authorship and publication of these products is important not only to the research programs but also to the authors of these products, as authorship and publication influence their reputation, promotion, and funding support.

The authorship guidance developed by the U.S. Environmental Protection Agency's (EPA) National Exposure Research Laboratory (NERL) is presented here as a case study. Establishing an authorship standard in the Laboratory was of critical importance, as the Laboratory's research products often involve collaborative efforts between the Laboratory's scientists, other EPA scientists, EPA contractors, non-EPA colleagues, and cooperative and interagency agreement partners. Scientific and technical products resulting from the Laboratory's research include books and book chapters, communication products, internal reports, journal articles, proceedings, presentations, published and unpublished reports, newsletters, and more.[1]

The Laboratory's authorship guidance was developed based on results of a scientific literature search of existing authorship guidelines conducted in 2010 and was further refined through input from management and staff from throughout the Laboratory. The guidance established uniform criteria for authorship of scientific and technical products and addresses author order; equal contributorship; unique coauthorship issues, such as shared first authorship, senior authorship, and group authorship; author responsibilities; authorship abuse; contributorship statements; acknowledgments; and dispute resolution. While this guidance is reproduced here with the consent of the Laboratory, the guidelines presented herein should not be construed as the current authorship guidance of this Laboratory or any associated laboratory or agency, as authorship convention is constantly evolving within and across disciplines.

Although much of the guidance on authorship and contributorship in the literature was initially formulated for biomedical publications, many of the underlying concepts and principles are applicable to all areas of science, and hence have been embraced by a number of other scientific fields as well. While not exhaustive, we feel the list of topics provided herein is a strong starting point for other scientific research organizations needing to prepare authorship guidance of their own.

JOSEPH E FLOTEMERSCH is an ecologist at the U.S. Environmental Protection Agency, Office of Research and Development. JUSTICIA RHODUS is an environmental science editor with CSS-Dynamac, a contractor to the U.S. Environmental Protection Agency.

CONTINUED

Authorship Criteria

Generally, the guidance discussed herein defines an author as someone who has made substantial contributions to the published research.[2–10] For the sake of discussion, a "substantial contribution" is considered "intellectual" in nature.[2,3] Adapting the criteria developed by the International Committee of Medical Journal Editors (ICMJE),[5] the Laboratory's authorship criteria define an author as an individual who has contributed to the published research as follows:

1. Made substantial intellectual contributions to one or more of the following:
   a. Conception and design (e.g., formulation of hypotheses; development of study objectives; definition of experimental, statistical, modeling, and analytical approaches)
   b. Acquisition of data and modeling (e.g., nonroutine fieldwork, such as adapting or developing new techniques or equipment necessary to collect essential data; nonroutine labwork, such as development of new methods or significant modification to existing methods essential to the research; literature searches; theoretical calculations; and development and application of modeling specific to the research)
   c. Analysis and interpretation of data
2. Been involved in the writing or critical revision of the product to provide critical intellectual content
3. Read and given approval of the final product being submitted for clearance and any subsequent revisions following requested revisions by editors and reviewers

All authorship guidelines examined in the literature required a contribution to criterion 1 *or* criterion 2 at minimum. In embracing the importance of intellectual contribution, both criteria were included in the Laboratory's authorship guidance. With the credit of authorship comes responsibility, which explains criterion 3 requiring every author to approve the final version of the work to be published. In meeting criterion 3, it is the explicit responsibility of the lead or first author to initiate and maintain the inclusion of potential coauthors (i.e., those that have made a substantial intellectual contribution to the research) in all lines of communication for the project and in preparation of the project's scientific and technical product(s). Excluding such contributors, whether through active exclusion or lack of initiative, is unethical and can result in a technical product that falls short of its potential. Any and all individuals who have met criteria 1, 2, *and* 3, independent of their rank and affiliation, should be named as authors.[4,5,8,10] Provided they fulfill these three criteria, authors may include federal employees, contract employees, non-EPA scientific colleagues, cooperative agreement and interagency agreement collaborators, and others. It should be noted the International Committee of Medical Journal Editors has since updated their authorship criteria to include a fourth criterion: agreement to be accountable for all aspects of the work in ensuring questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.[6]

Contributions Not Meeting Authorship

Authorship should *not* be granted to those who do not meet the criteria for authorship. Providing routine assistance, acquiring funding, general supervision of research group members, and holding positions of authority (e.g., supervisory or management positions) are not criteria for authorship.[2,3,5,6,8,11–16] That is, supervisors and managers who aid or support the research are not automatically granted authorship without providing a "substantial contribution," as previously defined. Likewise, none of the following contributions, in and of themselves, meet the criteria for authorship:

- Providing a routine technical contribution (e.g., routine data collection, assistance in literature searches, technical writing and editing, routine data analysis, etc.)
- Providing previously published data, instrumentation, or materials obtained from a third party[3,10,17]

Individuals who have made a *routine* technical contribution (e.g., laboratory technicians, data collectors, field personnel, technical writers and editors, statisticians, or others who only perform routine data acquisition and analysis following the specific instructions of the research plan or standard operating procedure) but provide no other intellectual input to the research or scientific and technical product have not made a "substantial contribution."[3] To earn authorship, technical contributors must have made a substantial intellectual contribution to the research (as defined in criterion 1 above) and met the remaining two authorship criteria as well.[17]

Deciding where to draw the line between those who are worthy of authorship and those whose contributions are more appropriately named in the Acknowledgments is often a difficult aspect of publication.[18] The authorship criteria defined here will help with this challenge. All individuals who have assisted in the work reported in the scientific and technical product, but do *not* meet the criteria for authorship, should be recognized in the Acknowledgments.[2–6,8,10–14,16–19] Guidance on how to acknowledge these contributors is discussed in the section on Acknowledgments.

Establishing Authorship and Authorship Order

As science has become more specialized and collaborative, transdisciplinary research has become more common, and

CONTINUED

multiauthored publications have become the norm across scientific disciplines.[18,20–23] In fact, the National Academy of Sciences reported that the average number of authors per article increased more than twofold (from 3 to 7) in the past 30 years, with some journal articles having "more than 15 authors or no named authors at all, just a consortium representing a group of authors."[22] To help mitigate issues of authorship, the development of preliminary publication plans is advised.

Preliminary Publication Plans

Early in the research, the lead investigator or project chairperson should discuss with collaborators who is expected to contribute to the research project, what their role in the research is, publication plans, potential authors for scientific and technical products, publication leads, and potential authorship order.[24–26] All contributors to a research project should be aware of the authorship criteria and have a complete understanding of the type of work worthy of authorship. This upfront communication is especially important for avoiding authorship conflicts later in the project, and gives contributors outside of the Laboratory the opportunity to recognize this guidance and discuss authorship issues with their organization. If outside collaborators are bound by their organization's authorship guidelines and policies, this would be the time to reach agreement on how inconsistencies can be resolved.

The publication plans for a research project may be documented at an early stage of the process, but it is important to recognize initial authorship and authorship order can (and likely will) change as the research progresses (see section on Common Reasons for Change in Authorship). These initial decisions should be revised, as necessary, to ensure that final authorship and authorship order reflect the actual contributions of all contributors.[24,25,27] However, once the list and order of authors have been established initially, no changes can be made without the consent of the research contributors.[10,14,27]

Authorship Order and Equal Contributorship

Authorship order is based on the level of contribution put forth by each author, with the first (primary) author listed having contributed most to the work and coauthors listed in descending order of contribution.[10,23,27–29] The exception to this is when a "senior" author is listed last in the byline and designated by a footnote. To establish the level of contribution made by each author, we recommend determining what percentage of the work was performed by that individual (i.e., assigning a percentage of the contribution to each author). Authorship order is a collective decision of the research collaborators,[16] and depending on the scope of a particular project, several scientific and technical products could be planned, each involving different authors and/or different authorship orders.[24]

As a result of the emerging trend in transdisciplinary research, it is becoming more common that two or more coauthors could have contributed equally to the work. In cases of equal contributorship, this may be indicated by a footnote to the byline or author list, with a caption that reads, "These authors contributed equally to this work." Designations of equal contributorship, and authorship order in general, only reflect the relative contributions of authors. However, contribution statements may be used to disclose each author's contributions and discern the value of those contributions to the research (see section on Contributorship Statements).

Common Reasons for Change in Authorship

Changes to authorship and authorship order established early in a research project can entail adding additional authors, eliminating individuals initially identified as authors, or rearranging authorship order. Authors may be added to a scientific and technical product if (a) the project has expanded in scope, (b) the added individual possesses the expertise necessary to complete the research or address major concerns expressed by a reviewer of the publication or product, or (c) a contributor who was initially not expected to meet the criteria for authorship becomes significantly more involved in the product and now meets the authorship criteria.[26,30]

Likewise, an individual initially expected to serve as an author may be eliminated from the final authorship of a scientific and technical product because the author did not contribute to the project as originally expected and no longer meets the criteria for authorship. If the actual contributions of authors differs significantly from those originally expected or if an author accepts increased responsibility or delegates a portion of his or her responsibility to other authors, the authorship order should be revised to reflect the actual contributions of each author.

Unique Coauthorship Issues

Authorship credit is a critical issue in research publication and can have major career implications for those involved. As the number of scientists involved in collaborative research endeavors increases, unique issues are arising regarding recognition of authors, both in terms of reflecting contributions and in terms of publication records.[23] This includes identification of first and senior (last) authors and use of group authorship.

Shared first authorship

As discussed previously, the first author of a publication is the person who has contributed most to the work, which

CONTINUED

often includes contributing the most to writing the scientific and technical product.[10,23, 27–29] Because of the implications of first authorship for employment, promotion, funding, and award potential, the increase in transdisciplinary research has produced a rising trend in shared or multiple first authors (also referred to as co–first authors or joint first authors). In cases in which two or more individuals are identified as first author, a footnote can be used to designate equal contributorship, as described in the section on Authorship Order and Equal Contributorship.[2,26,27,31,32]

While the use of shared first authorship can be used to accurately recognize and credit individuals for their contributions, care must be taken to ensure the pressure to publish does not lead to abuse of this designation. It is also important to note that numerous issues regarding co–first authorship are still yet to be resolved within the general scientific community. For instance, while equal contribution can be designated in curricula vitae (CVs) by a footnote or similar method, review of a CV for first authorship may not detect this designation. Likewise, many bibliometric databases and counting methods are not currently capable of recognizing additional byline information about equal contribution and accurately allocating publication and citation credit.[33] To minimize conflicts over these issues, alphabetical order has often been used in listing equal contributors, but this option creates a permanent and unfair bias towards those whose last names appear early in the alphabet. A frequently used alternative is to use random selection (e.g., flip of a coin) to select authorship order. If several scientific and technical products are planned for the research project, another option is for co–first authors to be listed in different authorship orders for each. If authorship order is based on alphabetical or random order, this should be noted in a footnote to the byline or author list.

Senior authorship

In many scientific disciplines, the last author in the byline or author list also has major significance, and many times is thought to have made the second most important contribution, behind that of first author.[19,23,27,31,32] This individual, often referred to as the "senior" author, is typically the senior member of the research team—the senior scientist who served as the driving force intellectually (and possibly financially) behind the concept, organized the project, and potentially provided guidance throughout execution of the research. Senior authors are also sometimes the head of a research group, laboratory, or department under which the research was conducted; or a mentor or advisor to more junior scientists who are conducting the research.[19,23,27,32] In many cases, these senior scientists are at a point in their careers where they are able to conceive of more research projects than they can execute themselves. In order to implement the research in a timely fashion, these research concepts are often passed down to junior scientists, who take ownership of the project, execute the research, and assume the role of first, second, etc. author(s) for the project, depending on their contributions to the research. The senior individual serves to conceive of and organize the project and may provide guidance through to completion.

It is important to recognize individuals who make these types of substantial contributions to the concept and design of a research project, either in the byline (as a senior author) or in the Acknowledgements section (as a contributor), depending on whether the criteria for authorship have been met. That is, senior authorship is not automatically bestowed on senior scientists, but rather should depend on their contributions to the work in light of the authorship criteria.[27] Awarding authorship to a senior scientist, department or laboratory head, or mentor who does not meet the criteria for authorship is an abuse of authorship (see section on Authorship Abuses).[2,10,19,27] Senior individuals who aid or support the research do not get an automatic right to authorship without providing a "substantial contribution," as previously defined.

Like first authorship, senior authorship has implications for career development, funding, and award potential. Without the recognition of senior authorship, senior scientists may feel pressure to identify themselves as first author (even though they did not perform the majority of the work) or shelve the project until they have time to implement it themselves. Also important to note in the case of senior authorship is that citation credit could be lost if a large number of coauthors exist for the product. Buehring et al. found that the significant increase in author numbers per publication has led to limits being placed on the number of authors allowed in cited references.[32] Consequently, when the author list is truncated, the last position in the byline (e.g., the senior author) may be left off the citation.[32]

As in the case of multiple first authors, the increase in transdisciplinary research has produced a rising trend in shared or multiple senior authors. Because of this trend and the lack of a standardized position for the senior author in the author list, it is suggested senior authorship be indicated by a footnote to the byline or author list (when applicable), with a citation that reads, "senior author." Not all journals observe the "senior author" category, however (e.g., Environmental Science & Technology [ES&T]); ES&T uses the term corresponding author, which in most cases encompasses the roles of both senior and corresponding author (personal communication with Barbara Booth, Assistant Editor of ES&T).

Group authorship

The number of collaborative publications involving large numbers of investigators working under a single group name

CONTINUED

is on the rise in the sciences, particularly in the life sciences.[23] Group authorship may be appropriate for scientific and technical products when a large group of researchers has collaborated on a project, such as in the case of integrated, transdisciplinary research or development of a framework document or white paper. In the case of these large collaborative products, there may not be enough space to list all of the collaborators in the byline or author list, and not all collaborators may meet the authorship criteria; therefore it is necessary to determine how to communicate credit for these group efforts and identify responsibility for the product's contents.[4–6,16,34,35]

In group authorship products, the group should identify all individuals who meet the authorship criteria, the group name, and the preferred citation.[2,5,6,16] There are essentially two group authorship models;[4,16,34,35] The Figure provides sample byline and citation examples for each:[35]

1. *Authorship in which each person in the group meets authorship criteria*. In this case, the group name is listed as the author, with author names appearing in the byline and/or elsewhere in the product for proper indexing of author contribution.
2. *Authorship in which a select subgroup of the whole meets authorship criteria*. In this case, the group name and individuals who meet authorship criteria are named as authors. Nonauthor group members are identified in the Acknowledgments.

Tscharntke et al. suggest using alphabetical order when listing the authors of a group in the byline or elsewhere in the publication to avoid conflict or disharmony in the group.[23]As mentioned previously, using alphabetical order creates a permanent and unfair bias towards those whose last names appear early in the alphabet, and if used should be noted by a footnote to the author list.

Final Authorship and Authorship Order

The contributors to a research product must work together to make informed decisions regarding authorship and authorship order. Prior to publication, the publication lead is responsible for obtaining written authorship agreements from all authors, verifying that each individual meets the criteria for authorship, agrees with the contributions attributed to their name, and accepts responsibility for the intellectual content of the scientific and technical product.[14,30,36] The agreements should at a minimum contain:

- the author's name, affiliation, and contact information;
- the title of the product; and
- a brief paragraph stating the author (1) meets the criteria for authorship, (2) agrees with the contributions attributed to their name in the scientific and technical product and the percentage of contribution assigned, (3) gives final approval of the final submitted product, and (4) accepts responsibility for the intellectual content of the scientific and technical product.

Should contributors fail to come to a collective decision regarding authorship and author order, mediation may be required to resolve the dispute (see section on Dispute Resolution).

Authorship Responsibilities

All Authors

During preparation, review, and revision of scientific and technical products, authors are responsible for providing timely input regarding their specific contribution(s). In addition, all authors are responsible for the accuracy, editorial quality, and intellectual content of the product, and should be able to publicly describe the work detailed in the publication.[4–6,9,14] Authorship carries with it substantial credit, but also carries weight in allegations of research misconduct.[4,37]

Publication Lead/First Author

It is the primary responsibility of the publication lead (i.e., the first or primary author) to manage and coordinate the scientific and technical product from draft to review, clearance, and publication. The first author, in some instances, may delegate these tasks to others (e.g., the corresponding author, senior author, etc.), but still maintains overall responsibility for these tasks. Ultimate responsibility for the work and the validity of the product's contents rests with the first author. In consultation with the other contributors, the publication lead assumes responsibility for (and should be able to articulate the reasons for) coauthors and acknowledgees determinations and establishment of authorship order.[38] The first author must also ensure all contributions are accurately represented in the final scientific and technical product and the results and interpretation of input provided are consistent with the contributor's intent.[38]

Corresponding or Communicating Author

The corresponding author (sometimes also referred to as the communicating author) is responsible for submitting the scientific and technical product and serving as the point of contact for all communications with the publisher (revision, review, release of proofs, etc.). The corresponding author is responsible for relaying details about the publication process to other authors of the product and incorporating and representing all author changes. The name and email address of the corresponding author is often noted in the scientific and technical product, as he or she serves as a point of contact for any inquiries. After publication, the

CONTINUED

Group authorship in which each person in the group meets authorship criteria.

A. The byline and citation contain the group name, but no named individual authors.*

Byline: Group Name

Journal Citation: Group Name. Year. Title. Journal Volume: Page Numbers.

Report/Book Citation: Group Name. Year. Title. Publisher, Publishing Location.

B. The byline and citation contain the names of select individual authors** followed by the group name. Using the connector *and* indicates that there are additional members of the group who meet the authorship criteria, but are listed elsewhere in the publication.

Byline: Author 1, Author 2, Author 3; and the Group Name

Journal Citation: Author 1, Author 2, Author 3; and the Group Name. Year. Article Title. Journal Volume: Page Numbers.

Report/Book Citation: Author 1, Author 2, Author 3; and the Group Name. Year. Title. Publisher, Publishing Location.

Group authorship in which a select subgroup of the whole meets authorship criteria and are listed as authors on behalf of the group.

A. The byline and citation contain the names of individual authors followed by the group name. Using the connector *for* indicates that the authors in the byline represent the group, which also includes additional members who do not meet the authorship criteria.***

Byline: Author 1, Author 2, Author 3; for the Group Name

Journal Citation: Author 1, Author 2, Author 3; for the Group Name. Year. Article Title. Journal Volume: Page Numbers.

Report/Book Citation: Author 1, Author 2, Author 3; for the Group Name. Year. Title. Publisher, Publishing Location.

* Each individual author is listed somewhere in the publication. Note: Bibliographic databases may include individual author names in their citations or allow for retrieval of citations by group name and/or individual author names.

** Often publishers will require that at least one individual author be named "to assume the role of content guarantor."

*** Nonauthor group members should be listed in the Acknowledgments of the publication.

Figure. Group Authorship Byline and Citation Examples.[35]

CONTINUED

corresponding author manages all communication and correspondence regarding the product on behalf of the publication's coauthors. The corresponding author does not have to be the first author or senior author of the scientific and technical product, but should be an author who is able to answer questions about and provide materials related to the conduct of the study. In cases where the responsibilities of corresponding author are shared, each individual serving in this role should be identified as such. Listing more than one corresponding author may also be desired on collaborative products involving authors from different organizations, or when the first corresponding author is not a permanent Laboratory employee and a more long-term point of contact is warranted.

Authorship Abuses

The literature identifies several common abuses of authorship that either diminish the significance of, or fail to recognize, author contributions: *honorary* or *gift* authorship, *guest* authorship, *ghost* authorship, and *surprise* authorship.[2,11–1316,17,19,36] *Honorary* or *gift authorship* is authorship credit given to someone who has not contributed directly to the work but is in a position to expect or demand authorship (e.g., the head of a branch or division, or someone who helped to obtain funding).[2,8,10,19] In contradiction to honorary authorship, which is often offered out of a sense of obligation, *guest authorship* is offered to an individual whose name is expected to increase the credibility of the research and the likelihood of publication, even though others did the work.[2,11,12,19] Guest authors make no discernible contributions to the study and, therefore, do not meet the criteria for authorship. *Ghost authorship* is the failure to give authorship credit to an individual who meets the authorship criteria.[2,12,13,39] All individuals who have made a substantial contribution to the work reported in the scientific and technical product should be acknowledged as an author if they meet the criteria for authorship. If these individuals do not meet all the authorship criteria, they should be listed in the Acknowledgements. *Surprise authorship* occurs when an individual unknowingly finds their name on the byline of a publication without having contributed to the work and/or accepted responsibility for the publication's content.[36]

Efforts must be made to protect the integrity of scientific and technical products from these abuses of authorship. Establishing and enforcing criteria for authorship and requiring contributorship statements are two practices that can help to reduce these abuses.

Contributorship Statements

The purpose of contributorship statements is to have each author and contributor personally affirm his or her role in the research (from its inception to publication), to disclose publicly the contribution(s) that he or she has made, and to gain what has been described as "public responsibility for content."[9,11,19,40–44] The concept is for all contributors to disclose their specific contributions to the scientific and technical product (i.e., work conducted) and for this information to be included as a footnote to the byline or in a designated author contributions section for authors, or in the Acknowledgments section for nonauthors.[8,9,19,44] When necessary, the publication lead is responsible for obtaining contributorship statements from all contributors to the scientific and technical product. All contributors to the scientific and technical product should discuss and agree on the contributions that will be disclosed for each individual. The Table identifies examples of general research contributions.[4,25,38] Contributors may list more than one contribution, and more than one contributor may have contributed to the same aspect of the work.[9,44] Contributorship statements should be sent to the publication lead.

Contributorship statements in scientific publications are akin to a credit list, like those used in the film industry, but it is important to distinguish a contributorship statement from the credits listed at the end of a film, which indicate an individual's title, rather than the work that was done.[43,45] It is imperative that the work actually done be disclosed if honorary, guest, and ghost authorships are to be eliminated. Clear contributorship statements also allow readers and editors to know which contributors were responsible for which aspects of the research and who can be contacted for more information about different parts of the work.[41,44,45]

In addition to removing the ambiguity surrounding author contributions, these contributorship statements also perform a number of other functions:

- Support final determinations of authorship and author order[24,25]
- Reduce abuses of authorship[44]
- Meet journal or society publishing requirements[4–6,8–10,46–50]
- Provide clear information regarding an individual's contributions for consideration in promotion or funding evaluations[41,44]

Although varying authorship standards exist between scientific organizations and disciplines, the practice of contributorship statements enables the standards that have been applied for authorship to be open to public scrutiny by colleagues, editors, and readers.[40] This practice will not eliminate all abuses of authorship, but it does promote open discussion of who contributed what, and those individuals who would typically abuse the system will have to do so publicly.

The practice of disclosing contributorship provides accountability for work, which can be especially difficult in

CONTINUED

Table. Examples of General Research Contributions.[4,25,38]

Conception and Design	formulation of hypotheses; development of study objectives; defining experimental, statistical, and analytical approaches
Data Acquisition	fieldwork; labwork; theoretical calculations; literature searches
Analysis and Interpretation of Data	making sense of and presenting the results; data analysis (statistical or other)
Writing Publication	creating all or a substantive part of the scientific and technical product
Critical Revision of Publication	reworking the scientific and technical product for intellectual content before submission (not just spelling and grammar checking)
Approval of Final Publication	providing approval of the final product version to be published
Supervision	oversight and responsibility for the study; general supervision of the research group
Resources	funding; equipment; facilities; personnel vital to the project; unpublished data
Technical, Administrative, or Material Support	provision of materials, reagents, or analytical tools; technical writing and editing; peer review; quality assurance; computer runs; advice
Other	novel contributions

transdisciplinary and multicenter research projects. With regard to multiauthored, collaborative research projects, this practice may result in a large increase in the number of authors for a scientific and technical product, but this is appropriate recognition for those who make substantial contributions to the research.[17,44] Suggestions on how to address authorship in collaborative group products is presented in the section on Group Authorship.

With the increase in collaborative, interdisciplinary research efforts, there has been a long-acknowledged need for a system to properly attribute credit and accountability in the publications resulting from these efforts.[19] In 2014, a multistakeholder group met that need by developing the CRediT Taxonomy—a 14-role contributor taxonomy—for use in scientific publications.[44] This contributorship taxonomy has since been adopted by the CellPress and PLOS families of journals.[47,48]

Acknowledgments

Acknowledgment of contributions is warranted for all individuals and institutions that have provided assistance to scientific and technical products. The approach is similar to the way you are expected to formally acknowledge data sources, literature, personal communications, and software used in research or publications. All contributors who do not meet the criteria for authorship should be named in the Acknowledgments section of the product, with their affiliation and specific contributions defined.[4,10,14,44,51]

Contributions that warrant inclusion in the Acknowledgments include routine data collection and analysis; editorial or technical review and assistance (without prior or continuing involvement in the publication); peer review; quality assurance; identification and acquisition of funding; equipment, materials, and facilities; provision of unpublished data; computer runs; critical advice; administrative, technical, contractual, and/or logistical support; and general support by supervisors and management who aided or supported the project.[4,14,28,44,51]

In addition to defining the contributions of acknowledgees (nonauthor contributors), the Acknowledgments may also include disclosure of potential conflicts of interest of authors and acknowledgees, including financial interests and relationships; sources of funding and support; explanations of the role of sponsor(s); disclaimer statements, such as

CONTINUED

those now required for clearance of many laboratory's scientific products; and other notices.[4]

Like authorship, written permission should be obtained from individuals before their names appear in print in the Acknowledgments.[4–6,14,16] Like contributorship statements and authorship agreements, the publication lead is also responsible for ensuring written permission is obtained from all nonauthor contributors whose names will appear in the scientific and technical product, when necessary. These agreements should be received in writing and should meet the following requirements:

- the contributor's name, affiliation, and contact information
- the title of the product
- a brief paragraph stating the contributor (1) agrees with the contributions attributed to their name in the scientific and technical product and (2) gives permission for acknowledgment in the product

Dispute Resolution

Disagreements and conflicts over the assignment and ordering of authors are common because of the incentives and rewards associated with authorship, especially in the case of first authorship. Contributors to the scientific and technical product should first attempt to resolve any dispute over authorship issues themselves, through the careful consideration of the guidance contained in this document. However, if a contributor considers the outcome of this process to be unsatisfactory, the individual may request assistance from management to facilitate resolution. If resolution is unattainable with the assistance of direct management, the dispute should be elevated up one level of management. The publication lead, in consultation with the individuals serving in these management roles, will have the final authority to resolve the dispute. If the dispute involves coauthors from different organizations, management from involved organizations should be included in discussions to reach resolution.

A number of resources are available to assist in resolving these types of authorship disputes and other issues involving publication ethics, such as those offered by the Committee on Publication Ethics (COPE; publicationethics.org).

Conclusion

Regardless of how carefully and comprehensively prepared, no guidance on authorship will resolve all issues. Rather, authorship guidance should serve as a tool for those navigating the often contentious topic of authorship. Authorship convention is constantly evolving in response to the dynamic nature of publishing within and across scientific disciplines. For example, there is currently little concurrence among journals on how issues such as group, senior, and shared first authorship are handled. As a result, specific guidance on these topics is difficult to find. However, providing recommendations on how such issues might be handled is beneficial in the interim until such concurrence is reached. Final authorship guidance for an organization should be clear and concise but not overprescriptive so as to interfere with an organization's ability to deal with unique authorship situations. And any guidance on authorship should be viewed as a living document that will require periodic updates as new issues are identified and authorship convention evolves.

Acknowledgments

The authorship guidance presented in this document is a product of considerable discussion and input from across the U.S. Environmental Protection Agency's National Exposure Research Laboratory. We particularly acknowledge the numerous management and staff who provided critical review and comment during the development of this guidance and extend a special thanks to Lee Riddick (EPA) who helped coordinate these reviews. The U.S. Environmental Protection Agency through its Office of Research and Development partially funded and collaborated in the research described here under contract number EP-D-06-096 to Dynamac Corporation. It has been subjected to Agency review and approved for publication.

References

1. EPA (U.S. Environmental Protection Agency). National Exposure Research Laboratory policy and procedures for clearance of scientific and technical products (STPs). U.S. Environmental Protection Agency, Office of Research and Development, 2007.
2. Davidoff F. Who's the author? Problems with biomedical authorship, and some possible solutions. *Sci. Editor*, 2000, 23:111–119.
3. Browner WS. *Publishing and Presenting Clinical Research*. Lippincott Williams & Wilkins, 2006.
4. AMA (American Medical Association). *AMA Manual of Style: A Guide for Authors and Editors*. 10th ed. Oxford University Press, 2007.
5. ICMJE (International Committee of Medical Journal Editors). Uniform requirements for manuscripts submitted to biomedical journals: Writing and editing for biomedical publication. International Committee of Medical Journal Editors, 2008.
6. ICMJE (International Committee of Medical Journal Editors). *Recommendations for the conduct, reporting, editing and publication of scholarly work in medical journals*. International Committee of Medical Journal Editors, 2015. www.icmje.org/icmje-recommendations.pdf. Accessed 2016 July 7 2016.
7. ESA (Ecological Society of America). Code of ethics. Ecological Society of America, 2013. www.esa.org/esa/about/governance/esa-code-of-ethics/. Accessed July 7 2016.
8. BioMed Central. Editorial policies. BioMed Central, 2016. www.biomedcentral.com/getpublished/editorial-policies. Accessed July 7 2016.
9. PNAS (Proceedings of the National Academy of Sciences). PNAS editorial policies. *Proc. Natl. Acad. Sci. U.S. Am.*, 2016. www.pnas.org/site/authors/editorialpolicies.xhtml. Accessed July 7 2016.

CONTINUED

10. SfN (Society for Neuroscience). Guidelines for responsible conduct regarding scientific communication. Society for Neuroscience, 2016. www.sfn.org/member-center/professional-conduct/guidelines-for-responsible-conduct-regarding-scientific-communication. Accessed July 7 2016.
11. Rennie D, Flanagin A. Authorship! Authorship! Guests, ghosts, grafters, and the two-sided coin. *J. Am. Med. Assoc.*, 1994, 271:469–471.
12. Flanagin A, Rennie D. Acknowledging ghosts. *J. Am. Med. Assoc.*, 1995, 273:73.
13. Flanagin A, Fontanarosa PB, Phillips SG, Pace BP, Lundberg GD, Rennie D. Prevalence of articles with honorary authors and ghost authors in peer-reviewed medical journals. *J. Am. Med. Assoc.*, 1998, 280:222–224.
14. Sahu DR, Abraham P. Authorship: Rules, rights, responsibilities and recommendations. *J. Postgrad. Med.*, 2000, 46:205.
15. APA (American Psychological Association). Ethical principles of psychologists and code of conduct. American Psychological Association, 2010. www.apa.org/ethics/code/index.aspx. Accessed July 7 2016.
16. CSE (Council of Science Editors). CSE's white paper on promoting integrity in scientific journal publications. Council of Science Editors, 2012. www.councilscienceeditors.org/resource-library/editorial-policies/white-paper-on-publication-ethics/. Accessed July 7 2016.
17. Friedman PJ. A new standard for authorship. Council of Science Editors, 1998. www.councilscienceeditors.org/resource-library/editorial-policies/cse-policies/retreat-and-task-force-papers/authorship-task-force/a-new-standard-for-authorship/. Accessed March 22 2010.
18. Weltzin JF, Belote RT, Williams LT, Keller JK, Engel EC. Authorship in ecology: Attribution, accountability, and responsibility. *Front. Ecol. Environ.*, 2006, 4:435–441.
19. Rennie D, Yank V, Emanuel L. When authorship fails: A proposal to make contributors accountable. *J. Am. Med. Assoc.*, 1997, 278:579–585.
20. Hadorn GH, Hoffmann-Riem H, Biber-Klemm S, Grossenbacher-Mansuy W, Joye D, Pohl C, Weismann U, Zemp E (eds.). *Handbook of Transdisciplinary Research.* Springer, 2008.
21. Regalado A. Multiauthor papers on the rise. *Science*, 1995, 268(5207):25.
22. Cozzarelli NR. Responsible authorship of papers in PNAS. *Proc. Natl. Acad. Sci. U.S. Am.*, 2004, 101(29):10495.
23. Tscharntke T, Hochberg ME, Rand TA, Resh VH, Krauss J. Author sequence and credit for contributions in multiauthored publications. *PLoS Bio.*, 2007, 5:e18.
24. Winston RB. A suggested procedure for determining order of authorship in research publications. *J. Couns. Dev.*, 1985, 63:515–518.
25. Eisner R, Vasgird D, Hyman-Browne E. Responsible conduct of research: Responsible authorship and peer review. Columbia University, 2004. www.columbia.edu/ccnmtl/projects/rcr/rcr_authorship/introduction/index.html. Accessed March 22 2010.
26. Jabri E. To be or not to be an author. *ACS Chem. Biol.*, 2006, 1(4):185–186.
27. Reisenberg D, Lundberg GD. The order of authorship: Who's on first? *J. Am. Med. Assoc.*, 1990, 264(14):1857.
28. Schmidt RH. A worksheet for authorship of scientific articles. *Bull. Ecol. Soc. Am.*, 1987, 68:8–10.
29. Verhagens JV, Wallace KJ, Collins SC, Thomas TR. QUAD system offers fair shares to all authors. *Nature*, 2003, 426:602.
30. APA (American Psychological Association) Science Student Council. A graduate student's guide: Determining authorship credit and authorship order. American Psychological Association Science Student Council, 2006. www.apa.org/science/leadership/students/authorship-paper.pdf. Accessed March 22 2010.
31. Kennedy D. Multiple authors, multiple problems. *Science*, 2003, 301:733.
32. Buehring GC, Buehring JE, Gerard PD. Lost in citation: Vanishing visibility of senior authors. *Scientometrics*, 2007, 72(3):459–468.
33. Hagen NT. Harmonic publication and citation counting: Sharing authorship credit equitably—Not equally, geometrically or arithmetically. *Scientometrics*, 2010, 84(3):785–793.
34. Flanagin A, Fontanarosa PB, DeAngelis CD. Authorship for research groups. *J. Am. Med. Assoc.*, 2002, 288:3166–3168.
35. CSE (Council of Science Editors). The CSE recommendations for group-author articles in scientific journals and bibliometric databases. Council of Science Editors, 2006. www.councilscienceeditors.org/resource-library/editorial-policies/cse-policies/approved-by-the-cse-board-of-directors/cse-recommendations-for-group-author-articles-in-scientific-journals-and-bibliometric-databases/. Accessed March 22 2010.
36. Levy GN. Surprise authorship. *Science*, 1997, 275:1863.
37. Colorado State University. RICRO Report. Vol. 13. Colorado State University, Research Integrity and Compliance Review Office, 2009.
38. Lewis C, and the Leadership Council. Human exposure and atmospheric sciences division authorship guidance. United States Environmental Protection Agency, 2004.
39. Claxton LD. Scientific authorship part 2: History, recurring issues, practices, and guidelines. *Mutat. Res.*, 2005, 589:31–45.
40. Engler RL, Covell JW, Friedman PJ, Kitcher PS, Peters RM. Misrepresentation and responsibility in medical research. *New Engl. J. Med.*, 1988, 317:1383–1389.
41. Shapiro DW, Wenger NS, Shapiro MF. The contributions of authors to multiauthored biomedical research papers. *J. Am. Med. Assoc.*, 1994, 271:438–442.
42. Kassirer JP. Authorship criteria. *Science*, 1995, 268:785–786.
43. Patterson, M. Roll credits: Sometimes the authorship byline isn't enough. Guest PLoS Blog by Michael Molla and Tim Gardner. November 6 2007. blogs.plos.org/plos/2007/11/roll-credits-sometimes-the-authorship-byline-isnt-enough/. Accessed July 7 2016.
44. Brand A, Allen L, Altman M, Hlava M, Scott J. Beyond authorship: attribution, contribution, collaboration, and credit. *Learned Publishing*, 2015, 28(2):151–155.
45. Biagioli M, Crane J, Derish P, Gruber M, Rennie D, Horton R. CSE Task Force on authorship draft white paper. Council of Science Editors, 1999. www.councilscienceeditors.org/i4a/pages/index.cfm?pageid=3411. Accessed March 22 2010.
46. Portland Press Limited. *Biochemical Journal*: Submission guidelines. The Biochemical Society, date unknown. www.biochemj.org/content/submission-guidelines. Accessed July 7 2016.
47. Cell Press. CRediT taxonomy. Cell Press, 2015. www.cell.com/pb/assets/raw/shared/guidelines/CRediT-taxonomy.pdf. Accessed July 7 2016.
48. PLOS (Public Library of Science). Authorship. 2015. journals.plos.org/plosone/s/authorship. Accessed July 7 2016.
49. AlphaMed Press. Stem cells: Information for contributors. AlphaMed Press, 2016. onlinelibrary.wiley.com/journal/10.1002/(ISSN)1549-4918/homepage/ForAuthors.html. Accessed July 7 2016.
50. NPG (Nature Publishing Group). Nature Journals' authorship policy. Nature Publishing Group, 2016. www.nature.com/authors/editorial_policies/authorship.html. Accessed July 7 2016.
51. Benward J, Takefman J, and the MHPG Publication Ethics Task Force. MHPG policy on authorship and acknowledgements for MHPG Task Force projects. American Society for Reproductive Medicine, date unknown. www.asrm.org/uploadedFiles/ASRM_Content/About_Us/Specialty_Societies/Professional_Groups/MHPG/MHPG%20Principlesofauthorship.pdf. Accessed March 22 2010.